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(54) Cell circuit interrupter.

(57) The present invention relates to a galvanic cell having a failsafe circuit interrupter means for electrically isolating one terminal of the cell from the cell's electrochemical system when the closed end of the container (12) bulges beyond a predetermined amount, the interrupter means comprising a conductive member (28) externally secured to the bottom of the container (12) by conductive, electrically connected central (27) and peripheral (29) flange portions, only the flange portion (29) being electrically connected to the container (12) at the bottom periphery, the central portion (27) providing the terminal, and the cover being so adapted that contact between the two portions is broken on bulging of the container bottom.

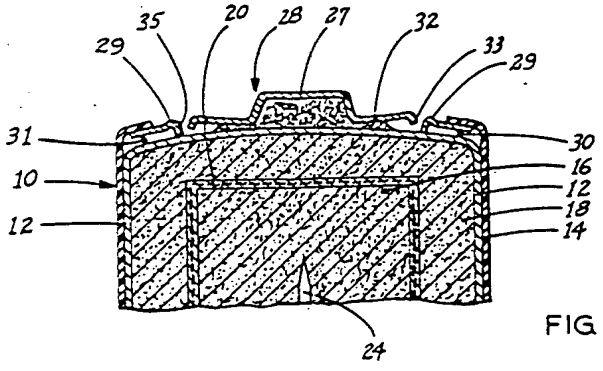

FIG 2

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CELL CIRCUIT INTERRUPTER

The present invention relates to galvanic cells having a failsafe circuit interruption means for electrically isolating one terminal of the cell from the cell's electrochemical system when the closed end of the container bulges beyond a predetermined amount.

Cell manufacturers have used a number of approaches to resolve the problem of electrolyte expelled during venting which can occur during or after the cell has been exposed to abusive conditions. One of the most common methods for preventing seal rupture due to abuse charging or the like is to insert a diode in the battery's electrical circuit. By eliminating the possibility of charging the cells, internal gas is not generated and the seal never ruptures. Another electrically related mechanism is a belleville shaped "flip switch". This device is triggered by bulging of the closed end of the cell's cylindrical container which causes a washer to invert and thereby break electrical contact. Another method involves the use of absorbants or electrolyte thickeners. The absorbent materials are usually located outside the seal area and beneath the cell's cover or jacket. As electrolyte escapes from a ruptured seal, the liquid is absorbed. Spew thickeners are mixed with the electrolyte and therefore are contained within the cell. The object of the thickener is to slow down and/or absorb any leakage that may occur. The disadvantage of using either an absorbent or a thickener is that both materials occupy space that otherwise could be used for active materials of the cell. A third procedure is to use an outer container and end covers as an electrolyte containment sytem.

U.S. Patent No. 3,676,221 discloses a battery comprising a plurality of stacked, disc-like sealed cells secured together by cups fitted over one cell and having bottoms spot-welded to the next cell and sidewalls spot-welded to the interfitting cell. A heat-shrunk sheath encloses the battery and has caps forming the poles. Between each pair of cells is a circular disc of insulating material against which the cup bottoms bulge upon expansion of the contents of the cells, thereby breaking the welds and electrically disconnecting the cells.

U.S. Patent No. 4,025,696 describes a disc-shaped washer which inverts after the bottom bulge exceeds a predetermined value. Prior to activation, the washer's inside diameter is slanted toward to container. As the container bulges, the bottom of the container pushes against the washer and eventually causes the washer to invert. This inversion electrically separates the bottom cover from the container. An open circuit results.

U.S. Patent No. 3,775,661 describes a cell in which internal pressure forces a diaphragm against a switch which electrically disconnects a charging device. The diaphragm is located inside a venting device which is attached to one end of the cell.

U.S. Patent No. 2,651,669 describes a bulge-activated switch that can be incorporated into a single cell battery or a multiple cell battery and operable such that a bulge can be used to open a switch or switches that control the cell's discharging and/or charging circuits.

U.S. Patent No. 3,617,386 describes a cell in which a thin sheet of metal with "spring-back" ability is positioned between the seal and cover of the cell so as to break the cell's electrical circuit when the bulge becomes excessive.

U.S. Patent No. 3,081,366 describes a sealed cell having a metallic sheet member connected to one electrode and its periphery insulatingly affixed to an open end of the casing, an overlying exposed metallic terminal insulatingly held over the sheet member. A movable switch portion normally connects an intermediate pressure-deflectable sheet member to the external terminal and, in response to outward motion of the deflected sheet portion under excess internal pressure, the switch portion disconnects the external terminal from the deflected sheet portion.

U.S. Patent No. 3,373,057 describes a cell in which the cover of the casing of the cell is provided centrally with an inwardly concave-contact button. A dished (concaveconvex) snap-acting spring disc of the automatic reset type is marginally sealed to the inside of the cover. An automatic reset disc after snapping in one direction in response to pressure on its convex side will return with snap action when the pressure is relieved. Thus, the disc is provided centrally with a sealed movable contact for engagement and disengagement with an internal fixed contact when the disc snaps to and fro. The arrangement is such that when the contacts are engaged the disc is slightly sprung toward the cover but short of causing snap action. This maintains good electrical contact pressure under safe internal gas pressures. The fixed contact is electrically connected with one set of battery plates and the other set of plates is electrically connected with the casing.

U.S. Patent No. 4,690,879 describes a cylindrical galvanic cell employing a unitary type cover as a fail-safe circuit interruption means for electrically isolating one terminal from the cell's electrochemical system when the bottom of the cylindrical cell bulges beyond a predetermined amount, so that the unitary cover breaks electrical contact

with the housing of the cell.

The present invention provides a galvanic cell comprising a conductive container closed at the bottom end and being in contact with one electrode, a cover in contact with the other electrode insulated from and situated over the open end, characterised in that a conductive member is externally secured to the bottom of the container by conductive, electrically connected central and peripheral flange portions, only the flange portion being electrically connected to the container at the bottom periphery, the central portion providing the terminal, and the cover being so adapted that contact between the two portions is broken when the container bottom bulges a predetermined amount.

In an alternative aspect, the present invention also provides a sealed galvanic cell comprising a conductive container open at one end and closed at the opposite end and including in the container a positive electrode, a negative electrode and an electrolyte with the container being in electrical contact with one of the electrodes; a cover mounted over the open end of the conductive container, the cover being secured to and electrically insulated from the conductive container and in electrical contact with the other electrode; a conductive member, the conductive member comprising a central portion and a peripheral flange portion and the central portion being in electrical contact with the peripheral flange portion, the central portion being secured by electrically insulating means to the external central area of the closed end of the container with the peripheral flange portion being secured to and electrically connected to the external peripheral area of the closed end of the container thereby adapting the central portion of the conductive member as the terminal for the electrode in electrical contact with the container; and wherein the central portion will separate from the peripheral flange portion of the conductive member when the centre area of the closed end of the container bulges a predetermined amount thereby electrically isolating the central portion terminal from the electrode in electrical contact with the container.

The circuit interrupters of the invention provide a galvanic cell with means for electrically isolating one terminal from the cell's electrochemical system upon reaching a predetermined bulge in the cell's housing. The circuit interrupters of the invention also have a minimum space requirement and do not diminish the space allocated for the active components of the cell, and are easy to make, cost effective and easy to assemble.

The galvanic cells of the invention exhibit a substantially reduced occurrence of electrolyte leakage due to abusive charging or overdischarging and do not require an additional electrical component.

It will, of course, be appreciated that neither the central nor flange portions of the conductive member need be continuous, although this is generally preferred. Thus, the flange may comprise a series of arms adapted to break away from the central portion when the bulge exceeds the predetermined value.

The conductive member may be composed, for example, of a central portion and a separate flange portion wherein the flange portion has a central opening to accommodate the central portion in an interference fit arrangement. The central portion is then forced within the opening in the flange portion to form an interference fit and to provide a suitable electrical contact between the central and peripheral flange portions. In operation, excessive bulging of the closed end of the container moves the central portion of the conductive member out of engagement with the flange, thereby breaking the electrical contact. Since the central portion of the conductive member is secured to and insulated from the bottom of the container, preferably by an electrically insulating adhesive, disengagement of the flange from the central portion will break the electrical contact between the central portion of the conductive member and the container of the cell, thereby electrically isolating one terminal (central portion terminal) of the cell from the cell's electrochemical system.

The conductive member may also be a unitary member comprising a central portion having an extending peripheral flange with a line of demarcation between the central portion and the flange composed of a thin or weakened section in the material of the conductive member. In operation, excessive bottom bulge of the container moves the central portion of the conductive member so as to break the central portion from the flange at the line of demarcation. As in the embodiment described above, one terminal becomes electrically isolated (the central portion terminal) from the cell's electrochemical system.

Suitable insulating securing means for securing the central portion to the bottom of the container include electrically nonconuctive adhesives. Suitable nonconductive adhesives are acrylic-type, epoxy-type, and cyanoacrylate-type adhesives. The adhesive should be applied so that it bonds the central portion of the conductive member to the bottom of the cell's container with sufficient strength to prevent tipping of the conductive member when the cell bulges. In addition, the adhesive must allow for electrical contact to be made between the bottom of the container and the flange.

To maintain the electrical contact between the flange and the external peripheral area of the container, the flange may be welded to the bottom of

the container using one or more welds, or by using a suitable electrically conductive adhesive. Examples of suitable such adhesives include: acrylic-type, epoxy-type, and cyanoacrylate-type adhesives mixed with an electrical conductor, such as silver or graphite. It is important that the flange remains in contact with the bottom of the cell container, so that when the central portion moves outwardly, the electrical connection between the central portion and the flange is broken.

In a preferred embodiment, the container is a cylindrical container, the electrically conductive means for securing the peripheral flange portion of the conductive member to the bottom of the container is at least one weld, and the conductive member comprises a disc-shaped central member with a peripheral flange portion and functioning as a cover member for the cell. This simple design provides a number of unique features. For example, when a nonconductive adhesive is employed to secure the central bottom of the conductive member to the central portion of the container, it can easily and conventionally be applied. Thus, the circuit breaker will require little or no additional space within the cell since the conductive member can function as a cover for the cell.

In the above preferred embodiment, two or more welds between the peripheral flange portion and the container's bottom are suitable. The electrically nonconductive adhesive for securing the central portion of the conductive member to the bottom of the container performs three functions. First, the adhesive holds the central portion substantially perpendicular to the cell's longitudinal axis during abusive charging so that the central portion will separate from the flange portion. Second, the adhesive electrically insulates the central portion from the bottom of the container after the central portion breaks away from the flange and, finally, the adhesive secures the parts of the cell together during normal handling and use.

The circuit interrupter means of the present invention may be incorporated into most cell constructions. The circuit interruption is generally irreversible such that the electrical connection between the conductive member and container is kept intact until the moment the central portion breaks away from the peripheral portion. This is a particularly advantageous feature of the present invention, since many other circuit breaking mechanisms generally pass through an interim phase in which electrical contact is sporadic. This phenomenon can result in "chattering" at the point of contact. The present circuit interrupters are also inexpensive to manufacture, since there are no costly parts to purchase. A small amount of a commercially available adhesive is the only extra component for most cell designs.

In the above preferred embodiment, the controlling characteristic for making the circuit interrupter work is the means used for electrically connecting the central portion to the peripheral flange portion of the conductive member. The means used should be sufficient to maintain normal electrical contact during storage and discharge and be adapted to break or separate the central portion from the peripheral flange portion of the conductive member when the cell bulges above a predetermined amount.

In some applications the control of the degree of bulge required to activate the circuit interrupter is critical. The circuit interrupter should not be activated by an amount of bulge that would normally occur when the cell is subject to high temperature storage, for example. Thus the degree of bulge must be beyond the normal bulge that may be encountered in high temperature storage but below the degree of bulge caused by pressure build-up needed to activate the vent to allow electrolyte to escape. For example, in a standard type alkaline D-size cylindrical cell (2.277 inches high and 1.318 inches. diameter - 57.84 mm x 33.48 mm), the bottom of the container may bulge as much as 0.64 mm (0.025 inch) when stored at 71° C for an eight week period,and will vent when the bulge exceeds 1.8 mm (0.070 inch). Consequently, for this size and type cell system, the central portion should generally be designed to activate the circuit interrupter when the bulge is between about 0.76 mm and about 1.8 mm (about 0.030 and about 0.070 inch).

The present invention is ideally suited for alkaline cells employing an MnO_2 positive electrode, a zinc negative electrode and an electrolyte solution comprising potassium hydroxide.

The present invention will now be further illustrated with respect to the accompanying drawings in which:

Figure 1 is an elevational view partially in cross-section of an alkaline manganese dioxide zinc cell embodying a circuit interrupter means of the present invention;

Figure 2 is an elevational view of part of the cell in Figure 1 showing the rim of the central portion of the cover separated from the peripheral flange portion;

Figure 3 is an elevational view partially in cross-section of another alkaline manganese dioxide zinc cell embodying a circuit interrupter means of the present invention;

Figure 3a is a cross-sectional view taken along line a-a in Figure 3, and showing the line of demarcation between the centre and peripheral portion of the circuit interrupter;

Figure 4 is an elevational view of part of the cell in Figure 3 showing the cover's central portion separated from the cover's peripheral portion;

Figure 5a is a view of the central portion distinct from the peripheral portion of the circuit interrupter shown in Figures 1 and 2 useful in this invention; and

Figure 5b is a view of an assembled circuit interrupter.

Figures 1 and 2 show a typical alkaline galvanic cell 10 comprising an inverted-metallic cupped container 12 provided with an outer plastic shrink label 14. Disposed within the container 12 is an anode 16, a cathode 18, a separator 20 and an alkaline electrolyte which permeates the anode 16, cathode 18, and separator 20 respectively. An anode current pin type collector 24 extends lengthwise within the cell 10, parallel to the longitudinal axis of the cell, from a location in contact with the anode 16 to the negative end 26 of the cell 10 where it terminates.

A cup-shaped conductive cover 28 comprising a central portion 27 and a peripheral portion 29 is provided, the peripheral portion 29 being shown spot-welded 30-31 to the bottom of container 12. Central portion 27 of cover 28 is force-fitted within peripheral flange portion 29 to provide an interference fit that ensures good electrical contact between the central portion 27 and the peripheral flange portion 29. The peripheral flange portion 29 has a small vertical extending skirt 35 that mates in frictional relationship with a vertical extending skirt 33 extending from the central portion 27. The skirts may form a continuous depending flange or may be separate depending tabs disposed about the periphery of central portion 27 or about the inner wall of peripheral flange portion 29. Prior to welding the peripheral flange portion 29 of cover 28 to container 12, an electrically nonconductive adhesive 32 is placed between the bottom of container 12 and the central portion 27 of cover 28 over an area sufficient so that only the inner central area of central portion 27 of cover 28 will contact the electrically nonconductive adhesive 32, thereby leaving the peripheral flange portion 29 of cover 28 in electrical contact with container 12. Peripheral flange portion 29 of cover 28 is welded (30-31) to container 12 to assure good electrical contact between these components.

After a predetermined amount of bulge occurs to move the central portion 27 from within peripheral flange portion 29, the contact between the central portion 27 and the peripheral portion 29 is broken. As is evident from Figure 2, central portion 27 of cover 28 is still secured to container 12 via electrically nonconductive adhesive 32 but its electrical contact to peripheral flange portion 29 is broken, thereby electrically isolating central portion 27 from the container 12. By taking into account such parameters of the cover as size and material, this invention may effectively be used to isolate the central portion terminal 27 from the circuit of the cell prior to the cell venting or rupturing.

Figures 3 and 4 show another embodiment of the invention of an alkaline galvanic cell 11 similar to cell 10 shown in Figures 1 and 2, except that a different cup-shaped cover 28 is employed. Similar component parts of the cell shown in Figures 1 and 2 and Figures 3 and 4 are indicated by identical reference numbers.

A unitary cup-shaped conductive cover 40 comprising a central portion 41 and a peripheral flange portion 42 is shown with peripheral flange portion 42 spot-welded 30-31 to the bottom of container 12. Circular groove 43 forms a line of demarcation between central portion 41 and peripheral flange portion 42, the line of demarcation forming a weakened area in the material of the cover 40 so that when central portion 41 moves outwardly after being subjected to a predetermined amount of displacement, the cover breaks along the line of demarcation. This electrically isolates central portion 41 from peripheral flange portion 42.

Prior to welding the peripheral flange portion 42 of cover 40 to container 12, an electrically nonconductive adhesive 32 is placed betwen the bottom of container 12 and the central portion 41 of cover 40 over an area sufficient so that only the inner central area of central portion 41 of cover 40 will contact the electrically nonconductive adhesive 32 thereby leaving the peripheral flange portion 42 of cover 40 in electrical contact with container 12. Peripheral flange portion 42 of cover 40 is welded (30-31) to container 12 to assure good electrical contact between these components.

As is evident from Figure 4, after circuit-breakage, central portion 41 of cover 40 remains secured to container 12 via electrically nonconductive adhesive 32, but its electrical contact to peripheral flange portion 42 is broken, thereby electrically isolating central portion 41 from the container 12. By taking into account such parameters of the cover as size, line of demarcation and material, this invention may effectively be used to isolate the central portion 41 (terminal cover) from the circuit of the cell prior to the cell venting or rupturing.

Although the present invention has been described with reference to particular details, these details are not to be construed as limiting.

Claims

1. A galvanic cell comprising a conductive container closed at the bottom end and in contact with one electrode, a cover in contact with the other electrode insulated from and situated over the open end, characterised in that a conductive member is externally secured to the bottom of the container by conductive, electrically connected central and peripheral flange portions, only the flange portion being electrically connected to the container at the bottom periphery, the central portion providing the terminal, and the cover being so adapted that contact between the two portions is broken when the container bottom bulges a predetermined amount.

2. A cell according to claim 1 wherein the conductive member comprises separate central and flange portions, the central portion being force-fitted within the flange portion to provide both an interference fit and electrical contact between the portions.

3. A cell according to claim 1 wherein the conductive member is unitary, a weakened line of demarcation being provided between the central and flange portions so as to allow the member to break upon predetermined displacement of the central portion.

4. A cell according to claim 3 wherein the line of demarcation is a groove in the material of the conductive member.

5. A cell according to claim 3 wherein the line of demarcation is provided by perforations in the material of the conductive member.

6. A cell according to any preceding claim, wherein an electrically nonconductive adhesive is used to secure the central portion of the conductive member to the external central area of the bottom of the container.

7. A cell according to any preceding claim, wherein the peripheral flange portion is welded to the bottom of the container.

8. A cell according to any preceding claim, wherein the container is cylindrical and the central portion of the conductive member acts as a terminal for the cell.

9. A cell according to any preceding claim, wherein the container is in electrical contact with the positive electrode and the cover electrically insulated from the container is in electrical contact with the negative electrode.

10. A cell according to any preceding claim, wherein the container is in electrical contact with the negative electrode and the cover electrically insulated from the container is in electrical contact with the positive electrode.

11. A cell according to any preceding claim, where the positive electrode is MnO_2, the negative electrode is zinc and the electrolyte solution comprises potassium hydroxide.

12. A galvanic cell comprising a conductive container open at one end, closed at the opposite end and including in the container a positive electrode, a negative electrode and an electrolyte, with the container being in electrical contact with one of the electrodes; a cover mounted over the open end of the conductive container, the cover being secured to and electrically insulated from the conductive container and in electrical contact with the other electrode; a conductive member, the conductive member comprising a central portion and a peripheral flange portion, the central portion being in electrical contact with the peripheral flange portion, the central portion being secured by electrically insulating means to the external central area of the closed end of the container with the peripheral flange portion being secured to and electrically connected to the external peripheral area of the closed end of the container thereby adapting the central portion of the conductive member as the terminal for the electrode in electrical contact with the container; and wherein the central portion will separate from the peripheral flange portion of the the conductive member when the centre area of the closed end of the container bulges a predetermined amount, thereby electrically isolating the central portion terminal from the electrode in electrical contact with the container.

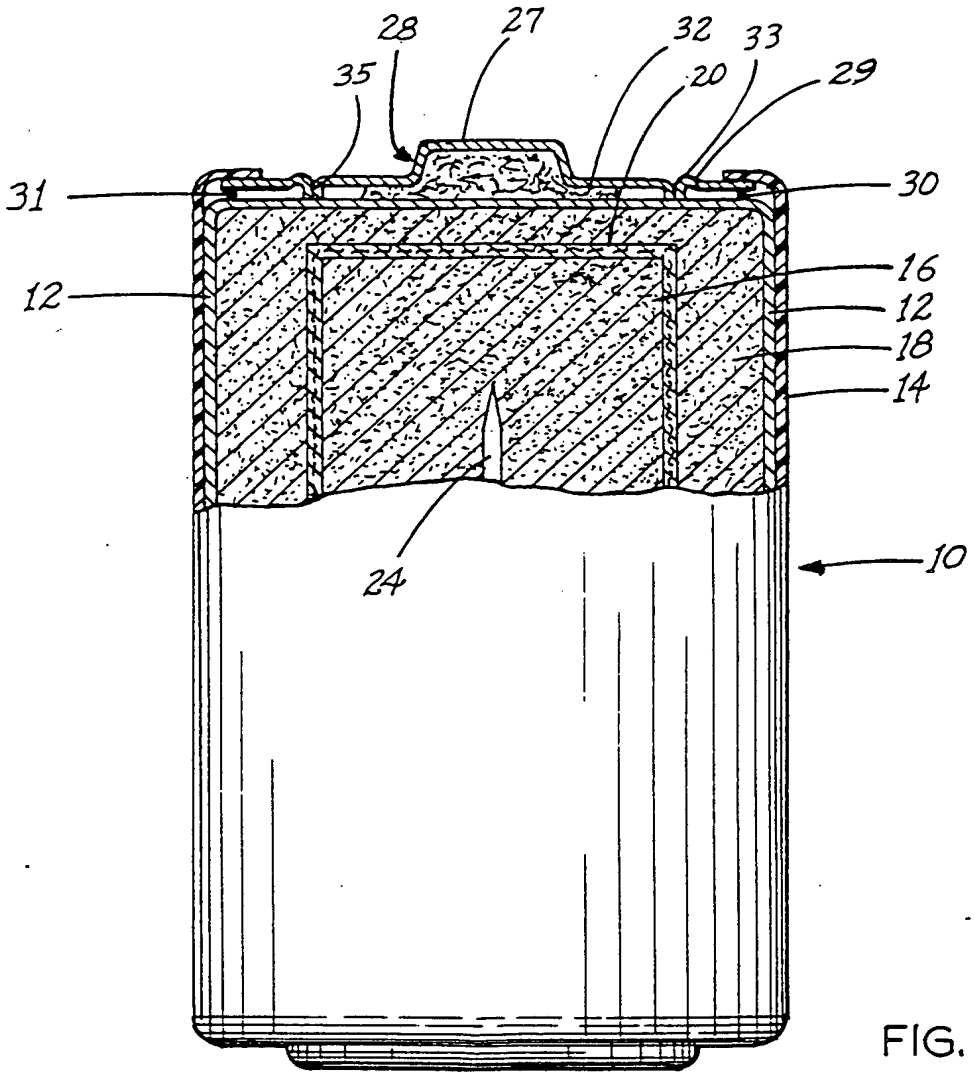
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FIG.1

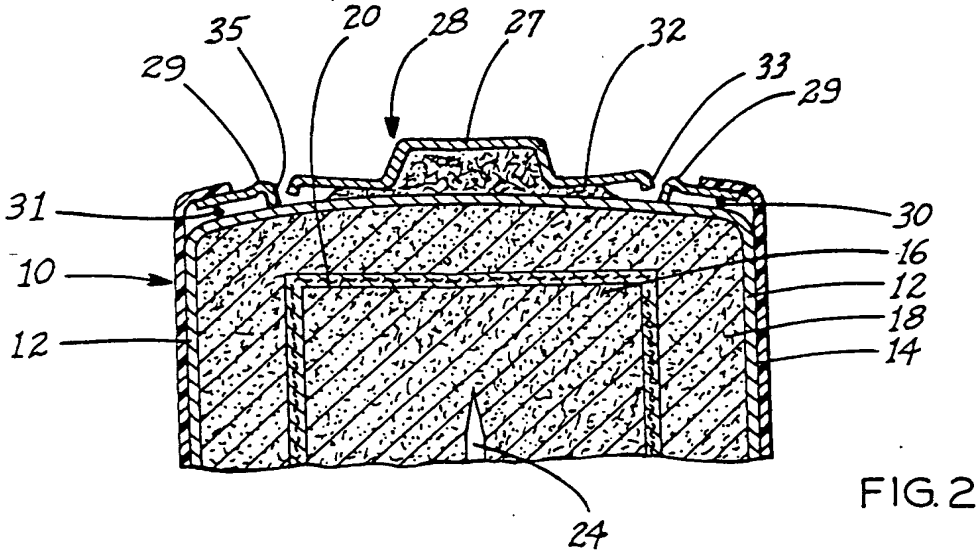
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FIG.2

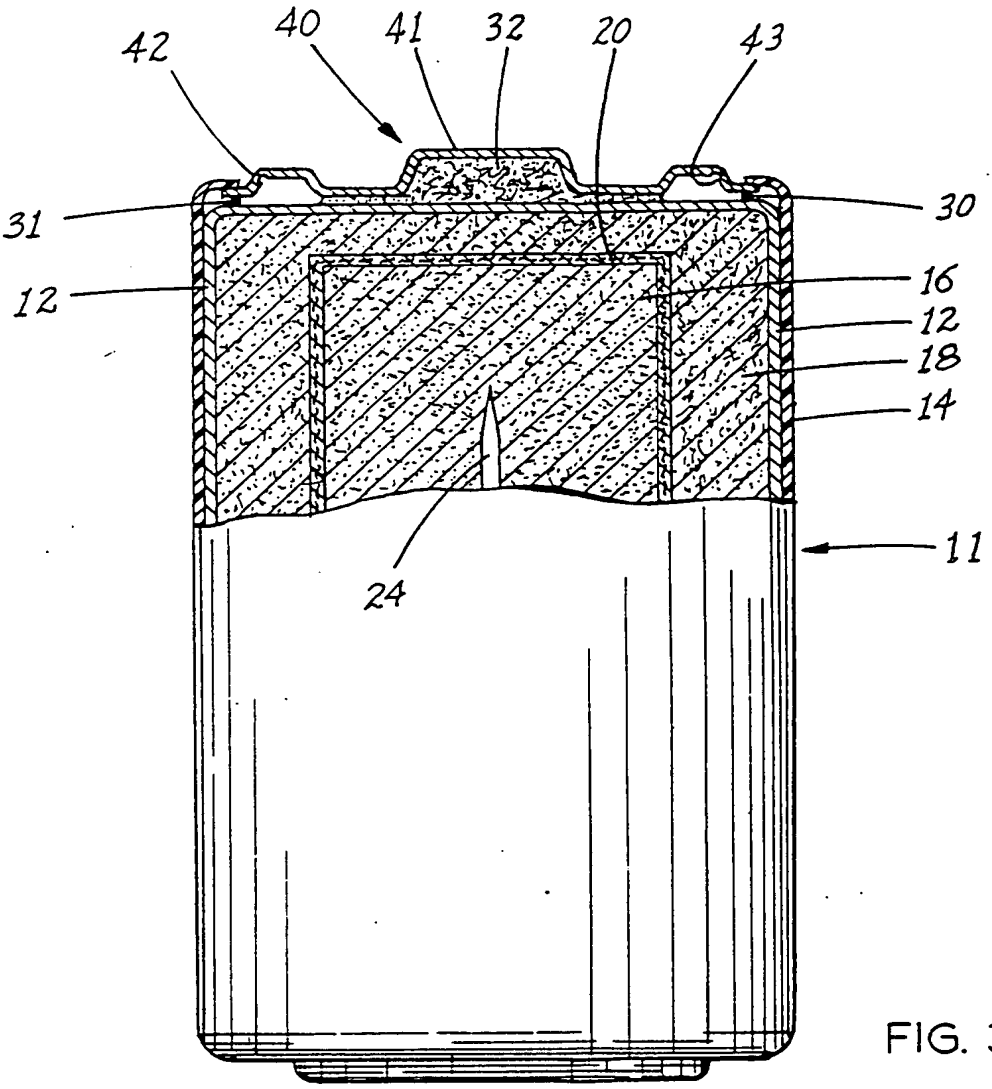
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FIG. 3

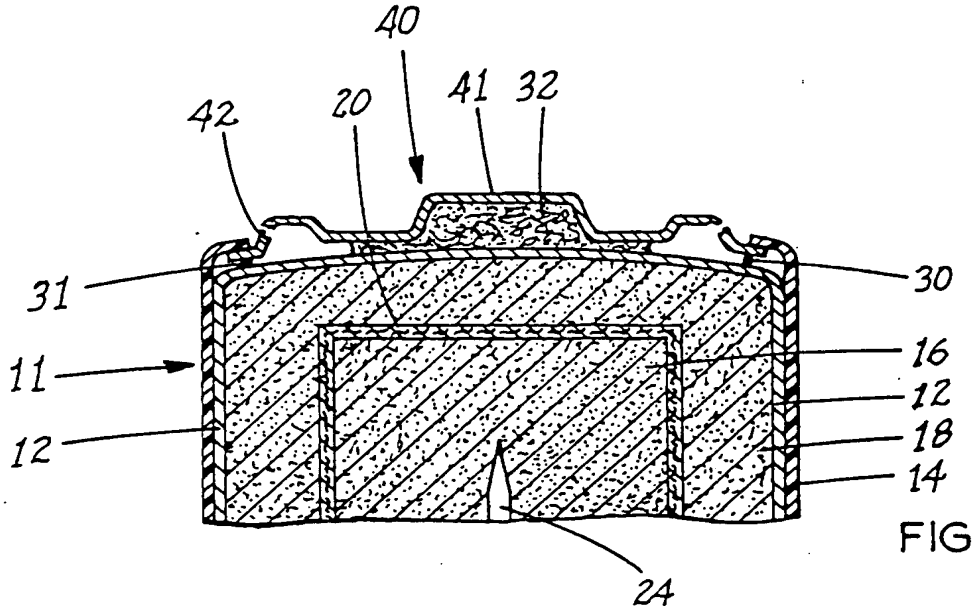
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FIG. 4

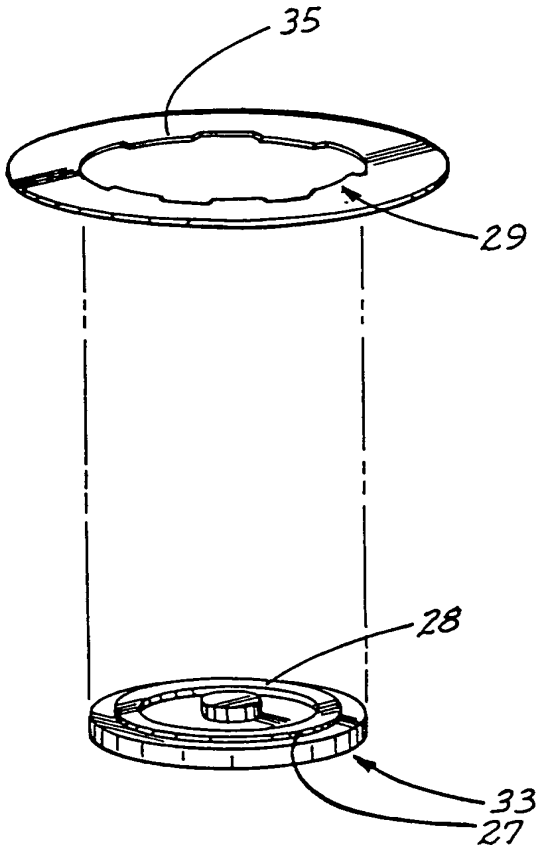

FIG. 5a

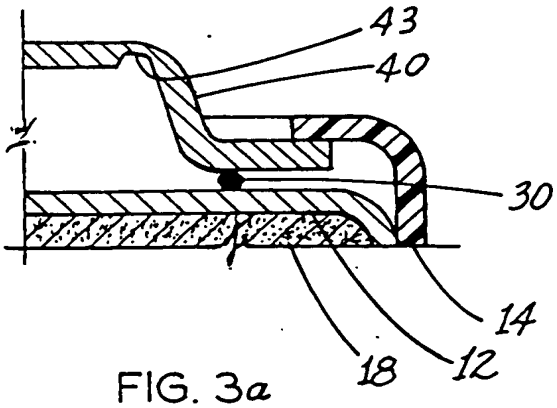

FIG. 3a

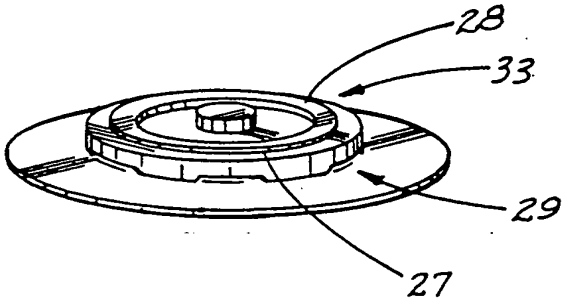

FIG. 5b

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 31 1097

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-4 028 478 (GARY RONALD TUCHOLSKI) * Column 1, line 60 - column 3, line 38 *	1	H 01 M 2/34
D,A	US-A-4 690 879 (H.R. HUHNDORFF) * Column 5, lines 1-43 *	1	
A	PATENT ABSTRACTS OF JAPAN, vol. 8, no. 190 (E-263)[1627], 31th August 1984; & JP-A-59 79 965 (NIHON DENCHI K.K.) 09-05-1984 * Abstract *	1	
A	US-A-4 601 959 (A. ROMERO) * Abstract; column 3, line 17 - column 4, line 28 *	1,3	
A	US-A-4 338 382 (D.H. FRITTS) * Abstract; column 3, lines 1-32 *	1	
A	DE-B-1 671 949 (TELEFONBAU UND NORMALZEIT) * Whole document *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 01 M 2/34
H 01 M 6/50
H 01 M 10/42

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	01-03-1989	DE VOS L.A.R.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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